# Novel Educational Methodology for Personalized Massive Open Online Courses

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*Abstract*— **In today's higher education, various learning concepts are applied, and in general, two approaches exist in designing web-based education systems with Massive Open Online Courses (MOOC): adaptive education systems and intelligent tutoring systems. For their success, it is important to actively include student(s) and to properly analyze theirs answers. These approaches enable creation of general topic courses, with content described by using only one teaching style or methodology, and main shortcomings are: missing or inadequate feedback from the students, system adaptation not focused on learning context, and course presentation and learning material limited to one teaching style. The main idea of this research is to develop Novel Educational Methodology (NEM), which will combine traditional and eLearning concepts into one new eLearning platform tailored to the needs or requirements of the student, student group, and teacher, thus, enabling creation and implementation of personalized MOOC(s), applicable in education, research and industry.**

## I. INTRODUCTION

Nowadays, two general approaches exist in designing web-based education systems with Massive Open Online Courses (MOOC): adaptive education systems and intelligent tutoring systems [1,2]. In an adaptive education system, the teaching materials are adapted based on the student preferences, but not based on the feedback that students provide during the course [3]. This adaptation is based on numerous preferences including the student's learning style, previously acquired knowledge, experience, grades, previously taken courses, etc. In intelligent tutoring system adaptation is performed based on the student response to the presented teaching material, without considering contexts, but it is possible to combines both ideas by adapting the sequence of teaching materials that is presented to a student based on both the context and the feedback of the student [4,5]. For the success of these methods, it is important to actively include student(s) and to properly analyze theirs answers. It should be noted that these approaches enable creation of general topic courses, with content described by using only one teaching style (methodology).

To conclude, main shortcomings of today's approaches in eLearning are missing or inadequate feedback from the students, system adaptation not focused on learning context, and course presentation (learning material) limited to one teaching style. Beside stated advantages and disadvantages to eLearning methods, there are practical shortcomings which are important to address, like: course materials are weekly adoptable to students with disabilities; they are not suitable for groups with different knowledge background and cognitive capabilities; they are poorly customizable to immersive business demands, etc.

## II. INTRODUCTION TO NOVEL EDUCATIONAL METHOD

The important question is: "How to create a sustainable learning system which will be tailored according to the requirements of the specific student (person), or domain of work (business) and education, but, which will also provide general and certified knowledge, and, work-based and lifelong learning?". This question defines following research goals:

- Learning system which will always provide contemporary content in accordance to the requirements of the society, university, and enterprises.
- Learning platform which is able to adapt to the specific needs coming from educational institutions, companies, public institutions and organizations, more specifically, learning platform which will be able to provide learning content to various kind of people (workers, students, people with disabilities, seniors, etc.), domain of work (health, agriculture, industry, etc.), education (schools, universities, business, business-to-universities and universities-to-business, etc.).
- Work-based learning will enable students to learn by using different kind of courses developed by SMEs and enterprises, which can be performed online by using web platform, or by learning on company physical site. Lifelong learning will be accomplished by providing constant upgrade of students and/or workers knowledge by using newly developed

 

courses from enterprises and universities or other applicable learning material.

In order to provide answer to the defined research goals Novel educational Methodology (NEM) was developed. NEM (Fig. 1) brings three important additions to the field of personalized eLearning, and it can be applied in education and industry:

- Molecule-Based Learning (MBL) – This method is based on how learning content is presented to the learner. It introduces molecules of knowledge. It is based on nucleus eLearning method (set of micro learning material) and sequence eLearning [7,8], but there are important differences. Knowledge Molecules contain one or more variants of the same nucleuses, i.e. they contain different variants of content explanations. One molecule can contain one or more nucleuses, and each of them can be applied individually, or combined, as presented in Fig. 2. Therefore, learning processes can be adapted to the various target groups, like learners, learning subjects, learning domains, and goals.
- Smart-sEquence Learning (SEL) – Sequence learning is known method, and it presumes learning processes where basic nucleus of learning material are presented to the learner in defined order.[8] In NEM complete learning material is created by combining molecules of knowledge and their content in a personalized sequence. Learning sequence can be created by aggregating molecule from different domains, thus creating new courses by using material already implemented in existing courses. New courses can be created automatically or semi automatically by using machine learning methods (by using classification), and/or by manually choosing learning material.

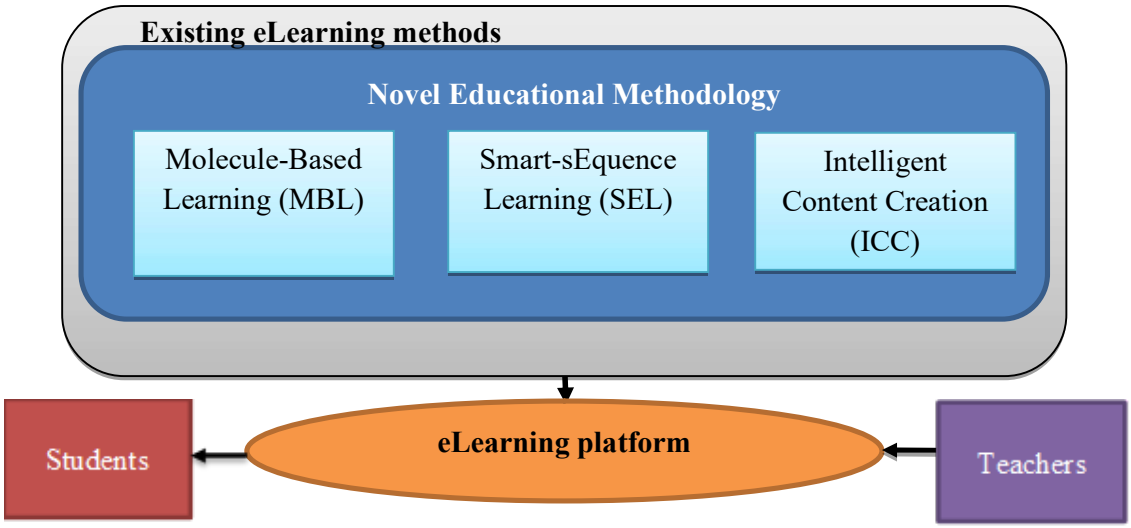


Figure 1. eLearning platform with integrated NEM

MBL and SEL are based on known learning technique, which uses small units of learning material, and it is already implemented in education. In this research, the new approach is defined by implementing different way of units formation and organization (molecules), and presentation (to learners).

- Intelligent Content Creation (ICC) [9,10] – Learning material for MOOC can be in a various form, and most common forms are video material and text. This material is created during course creation and it is fixed. In NEM, even on a micro level, video material and text can be formed based on the personal preferences of a learner and a teacher. This is possible due to the application of the digital avatar for the teacher, and by using semantic interpretation of the learning material, i.e. by using ontologies, and Natural Language Processing (NLP) techniques.

In order to create automated or semi-automated learning system (ICC), machine learning techniques are introduced into the NEM. This part of NEM is under constant development, but the initial technique which is currently integrated is supervised learning (SL). SL is a ML technique which uses known features and targets (categories/classification) to establish prediction patterns.

Based on the developed methods and current stage of the research, three types of courses are defined:

1. Generic courses – Courses which are created according to the trainer's specifications. These courses are defined as standard courses, yet they are created according to NEM specifications.
2. Learner defined courses – Courses tailored to the requirements of the specific learner. These courses are created manually by learner and composed of user selected nucleuses or molecules of knowledge.
3. Recommended courses – These courses are formed by following recommendations from the eLearning system. They are personalized to the learner, but they are created by the AI which is currently integrated into the NEM, and not manually selected from the database. These recommendations are formed by using questions and answers formed in the supervised learning way, i.e. questions are features and answers are their labeled values/categories. By completing the questionnaire, learner gets recommendation which nucleuses he should learn, i.e. the molecules of knowledge are

formed by the suggested and connected nucleuses (connection between nucleuses are known and already defined in MBL). It must be noted that this is a generalized method (recommendation system), and any course from any scientific or educational field can be created by following defined recommendations.

Material used for curses creation is gained from currently available resources at the authors university. No web data repositories are used, but they will be scanned and possibly used in NEM and additional software. Courses types 1 and 2 are already created for some subjects, while Course type 3 is under development.

### *A. Application of novel methodology in mechanical engineering – Machining tools learning example*

The new approach is to create flexible teaching materials in the form of courses oriented toward virtualization of manufacturing and other compatible systems. The basic idea is:

- A course is a complex object that is made up of a series of molecules (such as a machine assembly consists of machine elements), and the basic structure of the course is shown in Fig. 2.
- Molecules are made up of software and / or digital nucleus of different types.
- The main visualizations are digital objects created in specific graphics software, and represented by 2D or 3D representation (e.g. gearbox, or punching tool)
- Nucleus may also be audio recording of explanations of the functioning of a machine system, or any other knowledge representation.
- Nucleus are assembled into molecules and define certain entity of knowledge. Possible examples:
  - An audio recording in which the author explains the tool function and the 3D model of the tool can define one Molecule.
  - VR application that simulates the operation of a machine system,

Individual molecules can be combined, in order to define specific or personalized course, and an example is presented in Fig. 3, where comparison between traditional and new learning approach is demonstrated.

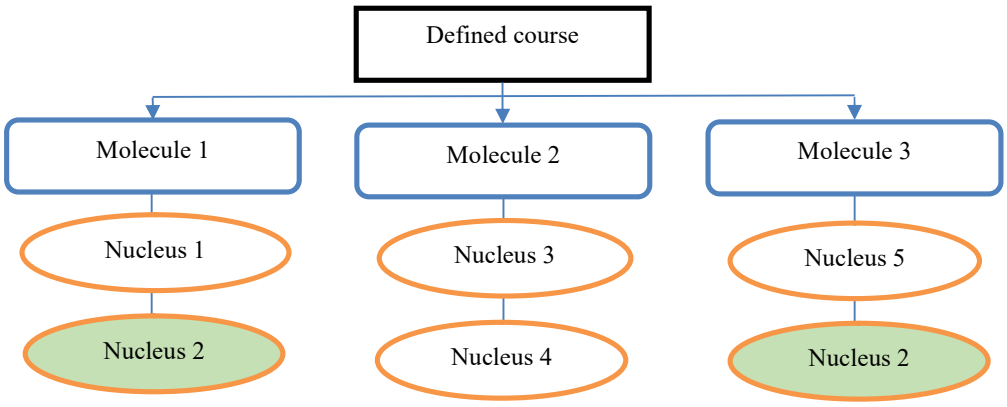


Figure 2. Structure objects (learning units) of the Specific course

Traditional course for machine tools consists of images/drawings of the tools assemblies and tools components which are presented to the learner and explanation is provided, as presented in Fig 3. Educational experience, gained through teaching in last twenty years, shows that it is of great importance to provide some kind of visualization of the tools, tools components and tooling processes. The students must be informed, of each tool component, its function and possible application beyond current tools and assemblies.

For example, one bolt which can be used for the fixation of the tool, can also be used for many other applications (in this tool, or completely different application), and its explanation and function demonstration is essential for the understanding of the whole tool assembly. This simple bolt is a basic element for the creation of nucleus explanation. Another element could be a nut, which usually goes with the bolt, but not always, which depends of the application. Nut can also be described by unique nucleus, but additional nucleuses can be added if there is a requirement. Author of the course can create 3D model of the bolt (first nucleus), add audio explanation (second nucleus), add textual explanation (third nucleus), and add everything which he finds appropriate, and form molecule of knowledge. The same can be done for nut, and any other element. After everything has been created, author can create VR or AR simulation and add all 3D models with attached audio explanation. In order to enable application of the created educational material, ePMOOC (e-Personalized Massive Online Courses) platform can be used. This platform represents a modern web framework, created for the application of NEM educational material, but not limited to it. It is based on the application of different software solutions (Moodle as eLearning platform [11], Unity as VR and AR tool [12], Blender as 3D modelling tool [12]) and combine them together to enable students access to the learning material.

Platform is currently under development (some modules are developed, while ICC method integration follows), and it will be available as open source software.

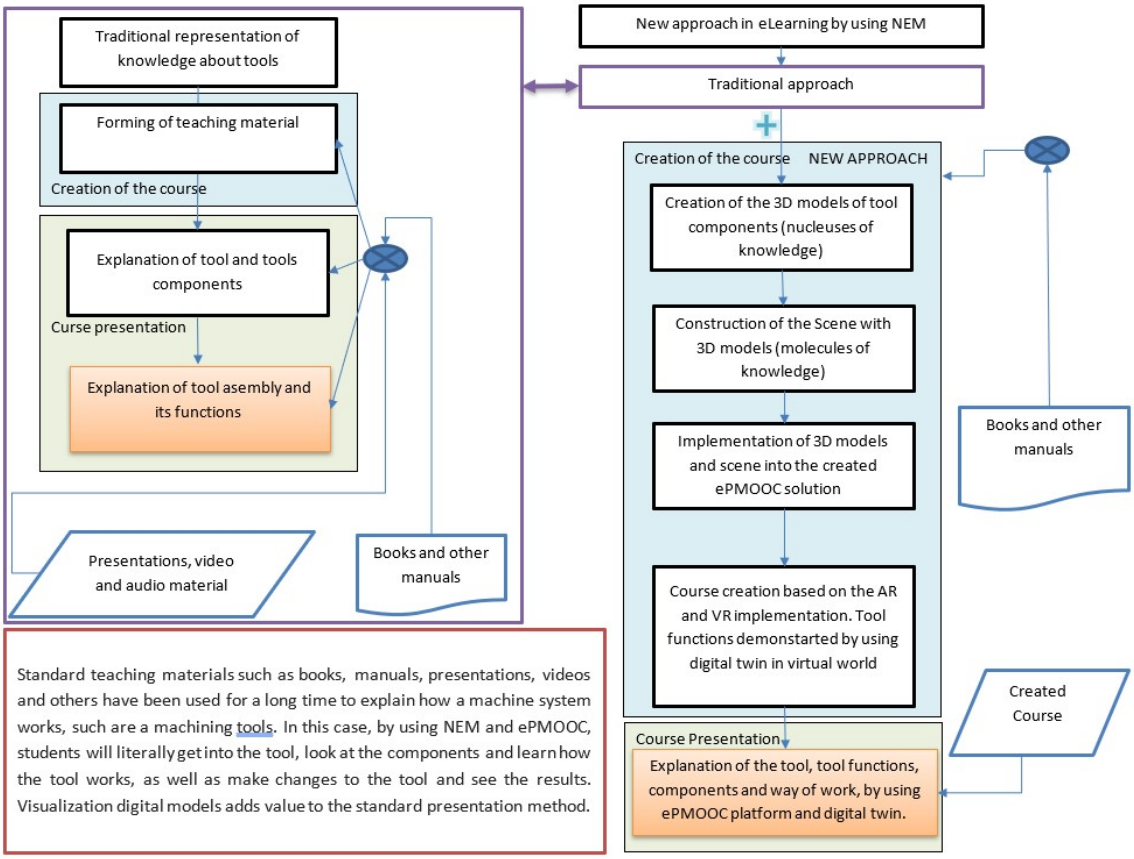


Figure 3. Comparison of the new approach with the traditional teaching method about tools applied in manufacturing

The example presented on Fig. 3 can be used for the creation of User Recommended course. For that purpose, it is essential to create AI recommendation system based on the data acquired from teaching processes at University.

In the current stage of development, features for this course are defined as (possible corrections can be done in the following period):

- Complexity of the subject (linearly, 0-1) – $X_1$
- Explanation of the components (linearly, 0-1) – $X_2$
- Explanation of the subassemblies (linearly , 0-1) – $X_3$
- Explanation of the main assembly (linearly , 0-1) – $X_4$
- Requirement for 3D visualization (binary – 0,1) – $X_5$
- Requirement for Audio visualization (binary – 0,1) – $X_6$
- Requirement for VR visualization (binary – 0,1) – $X_7$
- Requirement for tutoring (binary – 0,1) – $X_8$

Categories for this course can be defined as:

- Curse Recommendation, defined as target variable with multiple values/classes (1-8):
  1. Standard Course
  2. Audio recommended
  3. Video recommended
  4. VR recommended
  5. Standard + Audio + VR
  6. Standard + Audio + VR + Video
  7. Tutoring recommended
  8. All possible options included

For this purpose, Multinomial (Multi-class) Logistic regression and Random Forest methods will be used as first applicable methods, because they support multi target classification. Data will be collected in the following period and testing will be performed. Students will fill questionnaires, and results will be used as training and testing data for the classification. This will be initial approach, which will be used as basis for the further development of the ICC.

## III. CONCLUSION

In this paper, Novel Educational methodology (NEM) and novel eLearning platform are introduced. NEM uses modern learning techniques, which are based on known and in-house developed educational methods. MBL, SEL, and ICC methods are formed in order to help trainers to create modern courses, and to help learners to acquire knowledge in the best/personalized way. Several courses (Standard, type 1 and User defined courses, type 2) are already created, used, and verified by the students.

The future work will encompass several activities, like creation of additional courses and testing and improving the methods, especially ICC. It should be noted that, full integration of ICC method presumes creation of User adapted curses (type 4), which development is in early phase, but they will be fully automated, and ML supported. Together with the development of the presented methods, ePMOOC platform will be also adapted and improved, in order to provide best possible user experience to the trainers and learners.

By performing the defined future actions, one novel open-source learning platform will be fully established and verified, and hopefully used in educational processes world-wide.

## ACKNOWLEDGMENT

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